JOINT GEOPHYSICAL IMAGING

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RESEARCH OBJECTIVES

The objective of the Joint Geophysical Imaging project is to ultimately develop formal joint geophysical imaging algorithms for simultaneously inverting different types of geophysical data—to find a common, self-consistent earth model. The initial stages of this work have concentrated on demonstrating a methodology for combining time-lapse changes in electric conductivity and compressional- and shear-wave velocity with a detailed rock-properties model, to produce quantitative estimates of the change in reservoir pressure and fluid saturations.

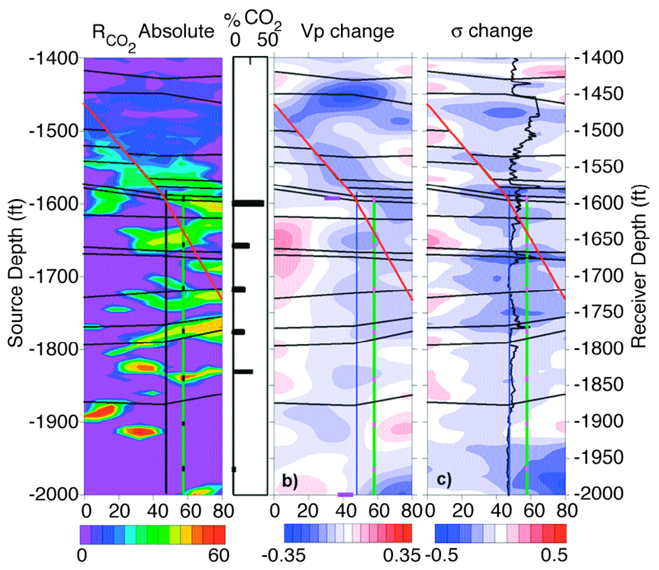

Figure 1. Changes in CO_2 dissolved in oil (a), changes in p-wave velocity (b), and changes in electrical conductivity (c). CO_2 injected into different depths is shown as % CO_2.

APPROACH

Crosswell electromagnetic (EM) and seismic data were acquired during CO_2 injection into the Lost Hills Oil field. Data were recorded before and during CO_2 injection. From well log data, a detailed rock-properties model was developed that related changes in the electrical and seismic properties of the reservoir to changes in pressure and fluid saturations. The rock-properties model was used to constrain inversion of the time-lapse data sets to produce time-lapse changes in the seismic compressional, shear, and electrical conductivity as CO_2 was injected. These time-lapse changes in geophysical parameters were combined with the rock-properties model to produce changes in reservoir pressure and fluid saturations (including changes in hydrocarbon gas, water, and CO_2 saturations).

A critical step was to first remove the effects of the reservoir-pressure and water-saturation changes by combining the EM and shear-wave velocity changes. Once the effects of reservoir pressure and water saturation changes were stripped off, the changes in acoustic velocity were used to map CO_2 saturation changes within the reservoir.

ACCOMPLISHMENTS/ SIGNIFICANCE OF FINDINGS

The newly developed procedure for unraveling the combined effects of reservoir pressure and fluid saturation changes produced a predicted change in CO_2 content in the reservoir oil. This change in CO_2 content is substantially better that that which can be obtained by traditional predictions (based on changes in geophysical parameters alone). Figure 1 shows the changes in CO_2 dissolved in oil compared to the changes in compressional velocity and electrical conductivity between the two observations wells used in the survey. There is a clear improvement in spatial resolution, along with accurate quantitative prediction of the CO_2 volume in place.

RELATED PUBLICATIONS

Hoversten, G.M., P. Milligan, J. Byun, J. Washbourne, L.C. Knauer, and P. Harness, Crosswell electromagnetic and seismic imaging: An examination of coincident surveys at a steam flood project. Geophysics, 2003 (in press); Berkeley Lab Report LBNL-48703.

Hoversten, G.M., R. Gritto, J. Washbourne, and T.M. Daley, Pressure and fluid saturation prediction in a multicomponent reservoir, using combined seismic and electromagnetic imaging. Geophysics, 2003 (in press); Berkeley Lab Report LNBL-51281.

ACKNOWLEDGMENTS

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